

CLAIMS

What is claimed is:

1. A line-narrowed gas discharge laser utilizing wavelength dispersion,
comprising:
 - 5 a resonator including therein a first discharge chamber filled with a gas mixture, the first discharge chamber containing a pair of electrodes connected to a discharge circuit and capable of discharging substantially along a discharge plane between the two electrodes, the discharging of the electrodes energizing the gas mixture and generating a laser beam in the resonator, the first discharge chamber
10 further including at least one window for sealing the first discharge chamber and transmitting the laser beam; and
a line narrowing module positioned along the beam path in the resonator, the line narrowing module including a dispersive element for wavelength selection of the laser beam, the dispersive element having a dispersion plane that is substantially
15 parallel to the discharge plane of the pair of electrodes.
2. A line-narrowed gas discharge laser according to claim 1, wherein:
the dispersive element is a diffraction grating.
- 20 3. A line-narrowed gas discharge laser according to claim 1, wherein:
the dispersive element further acts as a resonator mirror for the resonator.
4. A line-narrowed gas discharge laser according to claim 1, wherein:
the line narrowing module further includes at least one prism positioned along
25 a path of the laser beam.
5. A line-narrowed gas discharge laser according to claim 1, further comprising:
at least one slit aperture positioned along a path of the beam in the resonator,
the slit aperture oriented perpendicular to the discharge plane.
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6. A line-narrowed gas discharge laser according to claim 1, further comprising:
beam redirecting optics capable of directing the laser beam to make a
subsequent pass through the first discharge chamber in order to amplify the laser
beam.
7. A line-narrowed gas discharge laser according to claim 6, further comprising:
an optical isolation module positioned along a path of the beam in order to
optically decouple passes through the first discharge chamber.
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8. A line-narrowed gas discharge laser according to claim 6, further comprising:
at least one beam steering mirror capable of rotating the laser beam between
passes through the first discharge chamber.
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9. A line-narrowed gas discharge laser according to claim 1, further comprising:
a second discharge chamber positioned along the path of the laser beam in
order to amplify the laser beam.
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10. A line-narrowed gas discharge laser according to claim 9, further comprising:
an electronic synchronization system for controlling the timing of discharges
in each of the first and second discharge chambers.
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11. A line-narrowed gas discharge laser according to claim 9, further comprising:
an optical isolation module positioned along a path of the beam between the
first and second discharge chambers in order to optically decouple the first and
second discharge chambers.
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12. A line-narrowed gas discharge laser according to claim 1, further comprising:
a cylindrical lens positioned along a path of the laser beam between the first
discharge chamber and the line-narrowing module, the cylindrical lens serving to
correct wave front curvature error of the laser beam.

13. A line-narrowed gas discharge laser according to claim 1, further comprising:
a beam-splitting module positioned along a path of the laser beam to split the
laser beam into first and second channels;

5 first and second amplifier chambers, each of said amplifier chambers
positioned to amplify one of said first and second channels; and
a beam combining module for combining the amplified first and second
channels into an output beam.

14. A line-narrowed gas discharge laser according to claim 1, further comprising:
10 at least one optical etalon positioned along a path of the laser beam and acting
as a line-narrowing component for the laser beam.

15. A line-narrowed gas discharge laser utilizing wavelength dispersion,
comprising:
15 a resonator including therein a first discharge chamber filled with a gas
mixture, the first discharge chamber containing a pair of electrodes connected to a
discharge circuit and capable of discharging substantially along a discharge plane
between the two electrodes, the discharging of the electrodes energizing the gas
mixture and generating a laser beam in the resonator, the first discharge chamber
20 further including at least one window for sealing the first discharge chamber and
transmitting the laser beam;
a dispersion grating positioned along a beam path of the laser beam in the
resonator for wavelength selection, the dispersive element acting as a resonator mirror
and having a dispersion plane that is substantially parallel to the discharge plane of
25 the pair of electrodes; and
at least one slit aperture positioned along the beam path in the resonator, the
slit aperture oriented perpendicular to the discharge plane in order to control at least
one of the an angular spread and bandwidth of the laser beam.

16. A line-narrowed gas discharge laser according to claim 15, further comprising:

at least one prism positioned along the beam path in the resonator.

5 17. A line-narrowed gas discharge laser according to claim 15, further comprising:

beam redirecting optics capable of directing the laser beam to make a subsequent pass through the first discharge chamber in order to amplify the laser beam.

10 18. A line-narrowed gas discharge laser according to claim 17, further comprising:

an optical isolation module positioned along a path of the beam in order to optically decouple passes through the first discharge chamber.

15 19. A line-narrowed gas discharge laser utilizing wavelength dispersion, comprising:

a resonator including therein a first discharge chamber filled with a gas mixture, the first discharge chamber containing a pair of electrodes connected to a discharge circuit and capable of discharging substantially along a discharge plane between the two electrodes, the discharging of the electrodes energizing the gas mixture and generating a laser beam in the resonator, the first discharge chamber further including at least one window for sealing the first discharge chamber and transmitting the laser beam;

25 a line narrowing module positioned along the beam path in the resonator, the line narrowing module including a dispersive element for wavelength selection of the laser beam, the dispersive element having a dispersion plane that is substantially parallel to the discharge plane of the pair of electrodes;

30 a slit aperture positioned along a path of the laser beam between the first discharge chamber and the dispersive element, the slit aperture oriented perpendicular

to the discharge plane in order to control at least one of the an angular spread and bandwidth of the laser beam; and

a second discharge chamber in the resonator, the second discharge chamber capable of receiving the laser beam from the first resonator chamber and amplifying the laser beam before transmitting the laser beam as an output beam.

20. A method of generating laser light using a line-narrowed gas discharge laser; comprising:

generating a laser beam in a resonator of a gas discharge laser system, the gas discharge laser system including therein a discharge chamber filled with a gas mixture, the discharge chamber containing a pair of electrodes connected to a discharge circuit and capable of discharging substantially along a discharge plane between the two electrodes, the discharging of the electrodes energizing the gas mixture and generating the laser beam in the resonator; and

selecting the wavelength of the laser beam using a dispersive element positioned along the beam path in the resonator, the dispersive element having a dispersion plane that is substantially parallel to the discharge plane of the pair of electrodes.

21. A method according to claim 20, further comprising:

controlling at least one of the an angular spread and bandwidth of the laser beam using a slit aperture positioned along a path of the laser beam between the discharge chamber and the dispersive element, the slit aperture oriented perpendicular to the discharge plane .

22. A method according to claim 20, further comprising:

amplifying the laser beam by passing the laser beam through an amplifier chamber.

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23. A method according to claim 20, further comprising:
amplifying the laser beam by redirecting the laser beam through the discharge
chamber.

5 24. A method according to claim 23, further comprising:
rotating the laser beam using beam steering optics before redirecting the laser
beam through the discharge chamber.

10 25. A method according to claim 23, further comprising:
de-coupling the laser beam using an isolation module before redirecting the
laser beam through the discharge chamber.

26. A line-narrowed gas discharge laser utilizing wavelength dispersion,
comprising:
15 a resonator including therein a first discharge chamber filled with a gas
mixture, the first discharge chamber containing a pair of electrodes connected to a
discharge circuit and capable of discharging substantially along a discharge plane
between the two electrodes, the discharging of the electrodes energizing the gas
mixture and generating a laser beam in the resonator, the first discharge chamber
20 further including at least one window for sealing the first discharge chamber and
transmitting the laser beam; and
a line narrowing module positioned along the beam path in the resonator, the
line narrowing module including a dispersive element for wavelength selection of the
laser beam, the dispersive element having a dispersion plane that is at a substantially
25 non-perpendicular angle relative to the discharge plane of the pair of electrodes.